PHYSIOGRAPHIC NOTES.

BY

RALPH S. TARR.

GLACIATION IN ALASKA.—Thanks to the discovery of gold in Alaska, we are now learning a great deal concerning the geology and physical geography of that far-distant territory. For example, Part VII of the Twentieth Annual Report of the United States Geological Survey, a volume of over 500 pages, is devoted to reports of explorations in Alaska by Messrs. Eldridge, Spurr, Mendenhall, Schrader, and Brooks. While in some parts there seems to be need of editing, for the elimination of interesting but decidedly unimportant narration of experiences, there is a great amount of important material in each of these reports. They are, moreover, finely illustrated with excellent half-tones and maps, giving one many clear pictures of conditions in the parts of Alaska visited. Being in the nature of reconnaissance reports, much of the material is in a form of narration that would be difficult to summarize. Many points of physiography are brought forward, but perhaps the portions of most general interest are those relating to the evidences of past glaciation.

For example, Spurr's report upon Southwestern Alaska, including much of the Yukon valley, and reaching eastward to Cook Inlet, contains a rather full statement of the evidences of glaciation. The mountains were formed during the Tertiary revolution, then very decidedly lowered so as to admit the sea far inland and up to levels of fully 3,000 feet above the present shore-line. The evidence of this is found in the presence of rock-cut terraces and extensive deposits of Pleistocene gravels, which rest unconformably on the underlying folded mountain rocks. That the elevation to the present level was slow and intermittent is indicated by successive terrace-levels lower than the upper one. The evidence seems conclusive that these Pleistocene gravels are marine, and that at the time of their formation glaciers existed in the mountains, discharging icebergs into the sea.

With regard to former glaciation, Spurr says:

> There has been no general glaciation of southwestern Alaska, and if what glaciation there was constituted the Glacial period, then Alaska is still in it. For the evidence of ice action, shown in the deposits, the writer, as before stated, is inclined to look very largely to shore ice and to river ice, for these are undoubtedly very powerful eroding and transporting agents.

That there has been no general glaciation is indicated by the fact that, side by side with valleys containing glaciers, and in which they were formerly only slightly more extensive than now, are other valleys containing convincing evidence of never having been glaciated. Only valleys that are broad and U-shaped and that contain well-defined cirques are at present occupied by glaciers. In front of the existing glaciers are the sea-formed gravel deposits, mentioned above, which include boulders dropped by bergs. The glaciers did not reach below the ancient shore-line, apparently breaking off and forming icebergs, and thus ending in the sea. Since that time the advance of glaciers has been only slightly greater than at present, so that, from the beginning of the Pleistocene to the present time, the glaciers, according to Spurr, have been of about the same extent as those now existing there.

It is to be noted, however, that this does not preclude the possibility of a former very decided difference in climate; for the evidence seems to point toward a much lower stand of the land in this region when glaciation involved the more eastern parts of the continent. It would seem, then, that the uplift of the land was coincident with the change from the glacial climate to that of the present, so that there was at no time a condition of both climate and land elevation favoring general glaciation.

Mendenhall, on the other hand, whose territory includes a quadrangle to the east of Cook Inlet, comes to a rather different conclusion, as is indicated by the following quotation:

> Throughout the entire region studied the explorer is constantly confronted with evidence to prove that the present glaciers are but remnants of a system of vastly greater extent. Glacial scratches, polished surfaces, erratic boulders, typically glacial topographic features, nearly all of the usual forms of evidence, are abundant. It is difficult to decide just how extensive the older system was, but the conclusion reached is that a general ice-cap has not at any time buried this part of the continent, but rather that the greatest advance, of which records remain, was an expansion of the present system, essentially alpine, with its centres of accumulation, as now, in the two great ranges—the one along the coast, the other in the interior—and that from these centres ice streams flowed down the valleys, and spreading, fan-shaped sheets, of the type which Professor Russell has called Piedmont glaciers, rode out over the adjacent lowlands.

Such differences in deduction from observation bring up the interesting question as to whether the facts are actually different on the southern coast from those in the Yukon valley, or whether the difference in conclusion is the result of the interpretation which the observer places upon the facts. For example, is the evidence of glaciation in the Yukon valley buried beneath the gravel de-

posits? Or, on the other hand, are some of Mendenhall's evidences of former glaciation to be ascribed to the action of floating ice?

Schrader's report, which is based upon observations in the Copper River valley, also describes sea-deposited gravels of recent origin, and unconsolidated, reaching to elevations of 2,800 or 2,900 feet. His conclusion is that glacial activity was formerly much greater than at present. Brooks' reconnaissance included the Tanana river and a portion of the White river, upper tributaries of the Yukon. He finds no evidence of general glaciation in the Yukon, such as that noted by Dawson, McConnell, Russell and Hayes, although glacial deposits are found associated with the gravels which occur in his territory as in that of the others. A glacier once occupied the White River valley; but the glaciers of the Tanana valley and its tributaries appear to be of the Piedmont type, like that of the present Malaspina glacier in the Mount St. Elias region. He concludes that glaciers formed "a comparatively unimportant part in the physiographic development of the region," but that they did contribute silts and gravels, and also helped to bring about some drainage modifications.

From these various reports it seems difficult, as yet, to arrive at a definite conclusion concerning glaciation in Alaska, although the evidence as a whole seems to support the belief that, while glaciation did not extend over the entire territory, there were many glaciers, in some portions at least, which were decidedly larger than at present, broadening on the lowlands to the Piedmont condition. The results of further more detailed work will be awaited with interest.

These Alaskan reports contain many facts and suggestions concerning other features of physiographic nature. For example, Brooks describes the even sky-line which the mountain crests reach; and this, he concludes, indicates decisively the former existence of a peneplain whose exact age is doubtful, though somewhere in the Tertiary time, during a long period of stability of land. Rock benches found on valley sides are interpreted as the river bottoms of former time. His interpretation of the topography of this mountainous region, whose irregularities are accounted for by warping and by monadnocks, would be much more convincing if it had been accompanied by a consideration of the alternate hypothesis of the lowering of the mountain crests to a measure of sub-equality. The acceptance of a peneplain explanation for so rugged a region should require the most convincing evidence.

GLACIATION IN SIBERIA.—Another region that has been little studied in the past, and the question of whose glaciation is of great interest, is that of Siberia. The evidence from that vast area has been somewhat conflicting, and it is therefore of interest to record the note upon the subject which Purington has published in the *American Geologist* for January, 1901 (XXVIII, 45–47). Purington has spent three seasons in Siberia, during which time he has been on the outlook for evidence of glaciation. He finds that the lakes are not due to glaciation, but are merely remnants of former larger lakes. Deceptive imitations of evidences of glaciation frequently led him for the moment to consider that he had found signs of former glacial action; but upon study these were soon proved to be mere imitations. As a result of three years of travel, he records the fact that but one genuine instance of a fair-sized area of glaciation was found—namely, in the Yenisei valley, about fifteen miles southeast of Krasnoyarsk, in southern-central Siberia. There an area of about a hundred square miles, enclosed by a high granite wall and sedimentary rocks, contained abundant signs of local glaciation, among them drumlins, well-developed cirque topography, and a sand plain, but no scratched pebbles. Evidences of glaciation were found among the Altai mountains, where glaciers still exist; but the gold gravels of eastern Siberia, which by some have been ascribed to glacial action, were found to be not due to that cause.

These observations of Purington give support to the belief that general glaciation did not exist in Siberia, not so much because of the absence of a glacial climate as to the lack of high gathering grounds for the ice, together with the distance from the sea, which would prohibit extensive precipitation. That the climatic conditions were otherwise favorable for glaciation is suggested by the former extension of glaciers among the high mountains of central Asia, and also by this area of local glaciation, where the area of high land favored the gathering of snow.

ORIGIN OF YOSEMITE VALLEY.—Turner (*Proc. Cal. Acad. Sci., 3rd Ser., Vol. I, 261–321*), after sketching the history of the Sierra Nevada, in the vicinity of the Yosemite, takes up the discussion of the Yosemite Valley. He finds some evidence, though not absolutely conclusive, of two glacial periods. In considering the origin of this remarkable valley he discusses the various theories, but finds himself neither able to accept the Muir explanation, of glacial erosion, nor the Whitney explanation, of origin through block-

faulting. His conclusion is that it is not unlike other cañons, the world over, in being due primarily to *stream* erosion, aided, in this case, by the influence of the marked joints of the rock. According to Turner, cañons cut in the inter-glacial epoch were modified by the ice advance of the second glacial epoch.

In review of Turner's paper, Gannett (*Nat. Geog. Mag.*, *XII*, *1901*, *86–87*) vigorously asserts glacial origin, pointing out that there is an abundance of evidence of marked glacial action in this part of the Sierra Nevada, in the form of bare, rounded granite surfaces, U-shaped cañons, thousands of lake basins, and many cirques and hanging valleys. That this glaciation was long continued, and effective in its work, Gannett states, can be seen at a glance; and, moreover, that the line of demarcation between the channel and glacial erosion is clearly marked. Hanging valleys occur on the margins of the Yosemite Valley, and the Merced Valley changes abruptly to a V-shaped gorge at the foot of the Yosemite Valley. Gannett's conclusion, quite in contrast to that of Turner, is that the Yosemite is an ordinary and necessary product of *glacial* erosion.

Islands off the Coast of Southern California.—Partly through a study in the field, and partly from a study based upon the excellent United States Coast Survey maps of these islands, W. S. Tangier Smith (*Bull. Dept. Geol. Univ. of California*, *II*, *1900*, *179–230*) discusses the origin of the peculiar topographical features of the several islands lying off the California coast. Throughout this region there was land depression during the Miocene, followed by a period of erosion, during which the land was more elevated than now. A marked unconformity between the Miocene and Pliocene is proof of this erosion period. During the succeeding Pliocene depression the Miocene valleys were filled more or less, though much of this filling has since been removed.

During the post-Pliocene time some of the islands were mountain masses forming part of the mainland. Later folding, some occuring in the Pliocene, affected the whole region and formed some of the islands, as, for example, San Clemente. These mountain-building forces have acted intermittently down to the very present, and have included both faulting and folding; but the later movements have been of minor consequence in comparison to the earlier. In consequence of the movements, which at times have approached the condition of oscillation, there were local differential uplifts and downsinkings, as, for example, that which formed the San Francisco

Bay. During the Pliocene depression the land stood fully 1,500 feet below the present level, and this stand was long enough to permit the waves to cut off the tops of some of the islands. The post-Pliocene uplift, perhaps, connected the northern islands with the mainland; but the evidence indicates that the southern islands were not so connected. A slight, recent depression is shown by drowned valleys.

The paper is partly devoted to a discussion of the physiographic features of the sea-formed terraces, drowned valleys, and the stage of stream development. Smith states that a future more detailed study of the geology—which he believes is needed—may modify some of the details; but that the main object of his paper is to bring forward evidence that the latest general land movements on the islands have been the same as those on the neighboring mainland.